**INTERNSHIP PROPOSAL**

**Designing innovative crop rotations compatible with a reduction of animal-based food consumption under scenarios of organic farming expansions**

**Context**

Several modeling and prospective studies have recently analysed the consequences in terms of food production and greenhouse gas (GHG) emissions of a drastic expansion of organic farming (OF) systems at the national, European and global scales (Erb et al., 2016; Muller et al., 2017; Smith et al., 2019). Recently, studies conducted at the ISPA (Interactions Soil Plant Atmosphere) lab have shown that a drastic expansion of OF at the global scale would lead to a ~40% decrease in cropland production due to an increased competition for nitrogen (N) fertilizing resources (Barbieri et al., 2021). An increase of the global farmed area would thus be necessary to maintain the current production levels. Such increase could thus limit OF advantages in terms of CO2 emissions. At the same time, several works have shown that a transition towards food diets low in animal-sourced food are key to alleviate agricultural area requirement and related GHG emissions (Springmann et al., 2018; Tilman and Clark, 2014). Despite such evidence, to our knowledge, none of those studies has considered the interaction between changes in food consumption towards flexitarian, vegetarian or vegan diets and consumption or production of organic products. Indeed, moving away from animal-sourced food raises questions about the leverages to fertilise organically managed cropland soils due to the key role of animal manure to supply plant-available N. In order to alleviate such decrease in available manure resources, crop rotations need to be reshaped to make them more nitrogen self-sufficient. In addition, the decrease of animal population raises questions about the role and use of temporary pastures, which are nowadays a keystone of organic crop rotations. For these reasons, we need to design new organic crop rotation and cropping systems that would be adapted to scenarios involving a drastic or total decrease of livestock farming.

This internship will be part of the CLINORG (CLImate Neutral ORGanic farming) project, funded by the meta-programme INRAE METABIO. Several scenarios of expansion of organic farming systems will be developed and analyzed within this project. Such scenarios are characterized by different OF production objectives, namely i) the prioritization of crop-based food production, ii) the maximization of the nitrogen autonomy of organic farms and iii) scenarios involving a large diffusion of biogas production plans. Each scenario will be coupled with different degrees of reduction of livestock populations. One of CLINORG objectives is to develop spatial land-use maps representing a breakthrough in relation to current predominant organic crop rotations in Europe, as in line with the hypotheses of the different scenarios previously mentioned.

Thus, this internship aims at contributing to the design and the modeling of such land-use maps. The results will be used as input data for several models aiming at evaluating all scenarios (arable productivity, land-use changes and GHG emissions).

The CLINORG project associates several partners with expertise on crop and animal production (INRAE UMR ISPA, AGIR, PEGASE and Herbivores), land-use changes and economics (UMR Smart-Lereco and PSAE). Interactions between the intern and the different research labs will be possible.

**Objectives**

This internship will consist in exploring, designing and modeling innovative organic crop rotations in scenarios of OF drastic expansion at the European scale. More in details, it will aim at developing crop rotation in line with the hypothesis retained for each scenario of organic farming expansion at the European scale. The internship aims at translating the designed rotations into spatial land-use changes.

Overall, the internship will consist in the following steps:

1. Get familiar with the literature about organic farming expansion scenarios at large scales;
2. Participate at a literature screening about innovative and experimental organic crop rotations in different European geographic zones;
3. Define and design some “model” organic crop rotations in Europe, using the information collected at step 2, for different geographic region and OF expansion scenarios;
4. Define allocation rules in order to transform the predefined rotations into land-use maps, starting from the current agricultural land-use spatial distribution;
5. Develop land-use maps by coding or using already existing simple models simulating the spatial crop land-use based on the rules defined at point 4;
6. Spatially and statistically analyze the results obtained;
7. Depending on the quality of the simulations, you will participate at the redaction of a scientific manuscript based on your analysis.

**Internship conditions**

The internship will unfold within the ISPA joint research unit, associating INRAE and Bordeaux Sciences Agro on the INRAE campus in Bordeaux. You will be supervised by Noélie BORGHINO and Pietro BARBIERI and you will benefit from an extended research team, inducing several Ph.D. students and researcher of the ISPA unit. You will also benefit of the expertise CLINORG partners.

Expected dates range from January to June 2023, preferably, or from February to July 2023. You will receive a salary of ~ 550€ per month and you will benefit from a granted access to the INRAE canteen.

**How to apply**

Do you have a background in agricultural or environmental sciences? Do you have some taste for literature screening, modelling and data analysis? Are you interested in the proposed topic, with some curiosity about the spatial modelling and organic farming? Are you willing to develop you writing skills? Do not hesitate to apply! Python or R programming knowledge will be a further asset to your application.

Please, write a short letter explaining your background, you interest and motivation in the proposed topic. Send the letter, along with your CV to Pietro BARBIERI ([pietro.barbieri@agro-bordeaux.fr](mailto:pietro.barbieri@agro-bordeaux.fr)) and Noélie Borghino ([noelie.borghino@inrae.fr](mailto:noelie.borghino@inrae.fr)). ***Application deadline: 14/11/2022. The pre-selected candidates will be contacted for an interview.***

***Références***

Barbieri, P., Pellerin, S., Seufert, V., Smith, L., Ramankutty, N., Nesme, T., 2021. Global option space for organic agriculture is delimited by nitrogen availability. Nat Food. https://doi.org/10.1038/s43016-021-00276-y

Erb, K., Lauk, C., Kastner, T., Mayer, A., Theurl, M.C., Haberl, H., 2016. Exploring the biophysical option space for feeding the world without deforestation. Nature Communications 7.

Muller, A., Schader, C., El-Hage Scialabba, N., Brüggemann, J., Isensee, A., Erb, K.-H., Smith, P., Klocke, P., Leiber, F., Stolze, M., Niggli, U., 2017. Strategies for feeding the world more sustainably with organic agriculture. Nature Communications 8, 1–13. https://doi.org/10.1038/s41467-017-01410-w

Smith, L.G., Kirk, G.J.D., Jones, P.J., Williams, A.G., 2019. The greenhouse gas impacts of converting food production in England and Wales to organic methods. Nature communications 10, 4641. https://doi.org/10.1038/s41467-019-12622-7

Springmann, M., Clark, M., Mason-D’Croz, D., Wiebe, K., Bodirsky, B.L., Lassaletta, L., De Vries, W., Vermeulen, S.J., Herrero, M., Carlson, K.M., Jonell, M., Troell, M., DeClerck, F., Gordon, L.J., Zurayk, R., Scarborough, P., Rayner, M., Loken, B., Fanzo, J., Godfray, H.C.J., Tilman, D., Rockström, J., Willett, W., 2018. Options for keeping the food system within environmental limits. Nature. https://doi.org/10.1038/s41586-018-0594-0

Tilman, D., Clark, M., 2014. Global diets link environmental sustainability and human health. Nature 515, 518–522. http://www.nature.com/nature/journal/v515/n7528/full/nature13959.html